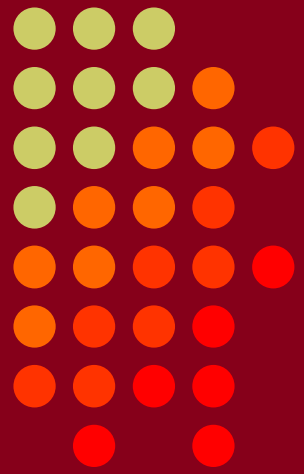
Basic Station Automation Techniques & Recommendations

Presented by N6TV

n6tv@arrl.net



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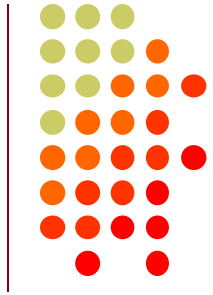
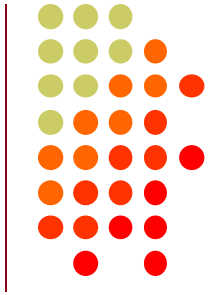
Presentation Overview



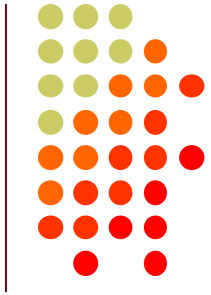
- Why Automate?
- Transceivers
- Amplifiers
- Band Decoders
- Antenna Switches
- Bandpass Filters
- Tuners
- Summary of Recommendations
- Q & A

Why Automate?



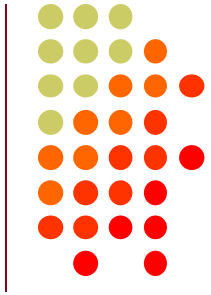
- Contesting is hard work
- You will get tired. You will get sleepy.
- Fatigue leads to *misteaks*
- Automation helps prevent *disastrous* mistakes
- Let the machines do what they do best
- You do the rest (while not getting much rest)

What should be automated?



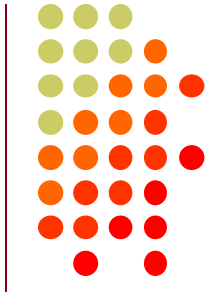
- Computer Logging of:
  - Date, time, frequency, mode, callsign, exchange
- Most transmissions (CQ, Your Callsign)
  - CW, RTTY, Voice Keying
- Changing bands on rig should automatically switch:
  - Antenna, Amplifier, Tuner
  - Bandpass filters / coax stubs
    (For Multi-Transmitter or SO2R)

What should *not* be automated?



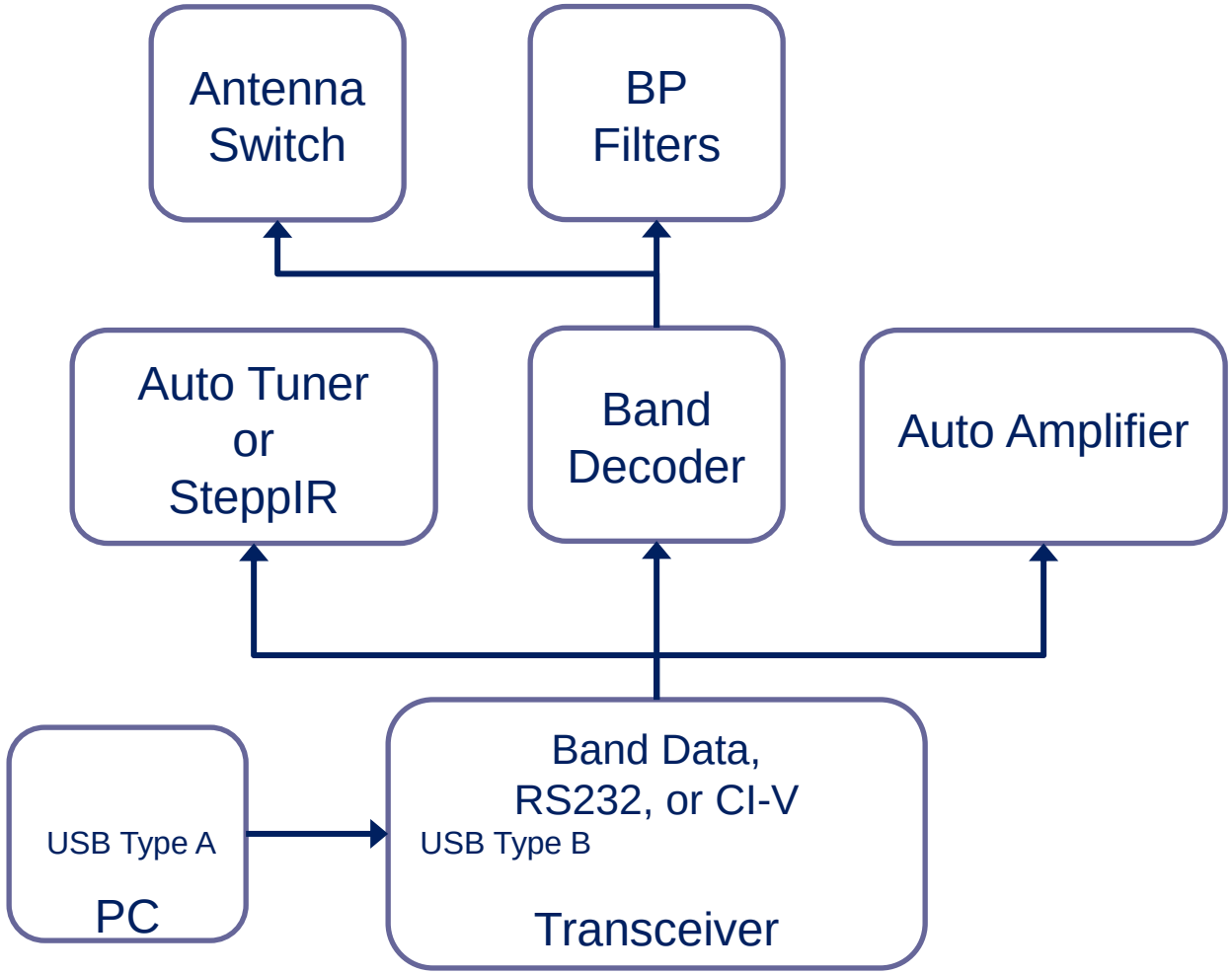
- CW copying
  - Do not rely on Code Readers
  - Do not blindly trust every cluster spot
- Voice Keying of Callsigns, Letter By Letter
  - “Oscar” “Hotel” “Two” “Bravo” “Alpha” “Delta”
- Exception: persons with disabilities
- Band change decisions
- How often to sign your call when running
- Where to put your VFO

Automating Band Changes Saves Time, *and* your Equipment

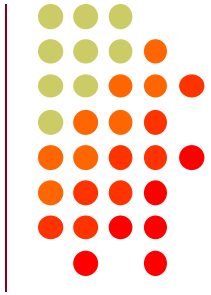


- Speed and Reliability is key
- Recommendation: Use hardware automation, not software
  - Everything should switch automatically even when PC is OFF or rebooting
  - Not always possible for some transceivers or peripherals
- Transceivers provide “Band Data” or “Operating Frequency” data to Peripherals
- Peripherals track transceiver using “Band Data” or “Operating Frequency” inputs
  - Amplifiers and Tuners usually have RF Frequency Counters that will override incorrect input

Transceiver Drives the Peripherals



Band Data



- Only provides transceiver's TX Band
  - Does not provide any VFO frequencies
- TX Band Data is ideal for:
  - Broadband solid state amplifiers without tuners
    - KPA500, ACOM 500S, 600S, 700S, 1200S, PGXL, some SPE
  - Band decoders for antenna switches / BP filters
    - Top Ten, Bandmaster, ShackMaster SM-8, Hamplus, BandPasser, OM6BPF, Unified Micro BCD-14, various BCD band decoder boards
- TX Band Data is *not* good enough for devices that need exact TX *frequency*
  - Automatic tuners and amplifiers with auto tuners
    - Kessler AT-AUTO, KAT500, TGXL
    - KPA1500, ACOM 2000A RCU, ACOM with 04AT/06AT tuner, most SPE
  - SteppIR controllers (FluidMotion, SDA100, OptimizIR)
  - Baby Loop controller

Band Data Encoding

- Yaesu and Elecraft use 4-bit “BCD”
  - Binary Coded Decimal, “Band A” to “Band D”
- Icom uses 2-pin Band Voltage: “8V Ref”, “Band”

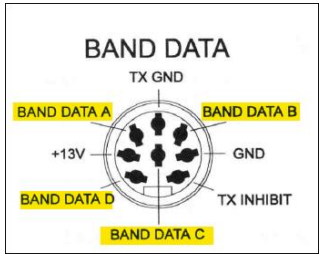
Band		160m	80m	40m	30m	20m	17m	15m	12m	10m	6m	None
Frequency		1.8	3.5	7	10	14	18	21	24	28	50	NA
Icom Voltage		7.0v to 8.0v	6.0v to 6.5v	5.0v to 5.5v	0.1v to 1.2v	4.0v to 4.5v	3.0v to 3.5v	3.0v to 3.5v	2.0v to 2.5v	2.0v to 2.5v	1.2v to 2.0v	0v
Yaesu	Band A	H	L	H	L	H	L	H	L	H	L	L
	Band B	L	H	H	L	L	H	H	L	L	H	L
	Band C	L	L	L	H	H	H	H	L	L	L	L
	Band D	L	L	L	L	L	L	L	H	H	H	L

* Icom outputs same voltage for 17m/15m and 12m/10m

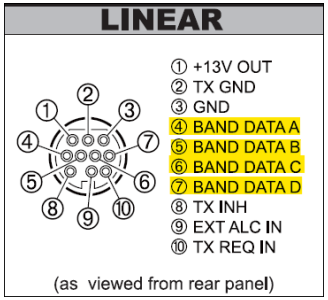
- Flex band data output requires special cable
- Kenwood does not provide any band data output

Yaesu Band Data Output Connectors

- Yaesu FT-1000MP, FTdx5000, FTdx9000
  Uncommon 262° “Horsehoe” 8-pin DIN



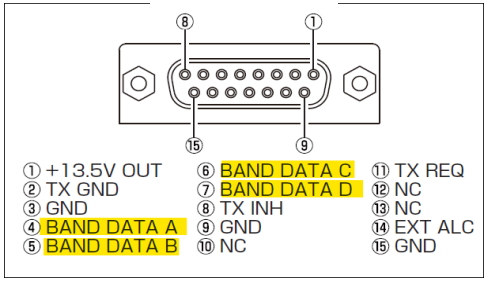
- FTdx10, FTdx1200
  Uncommon 8-pin MINI DIN



Yaesu Band Data Output Connectors

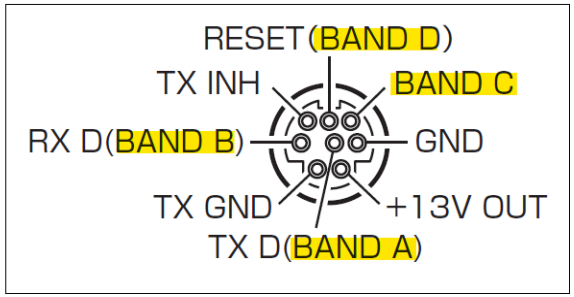
- Yaesu FTdx101D, FTdx101MP
  Standard DA-15F

LINEAR



- FT-710
  Standard 8-pin MINI DIN

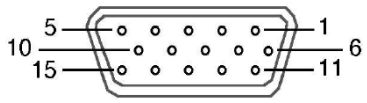
TUNER/LINEAR



Elecraft Band Data Output

- Elecraft K3 and K4
  Standard 15-pin DE-15F Connector (“ACC”)

Pin #	Description
1	FSK IN (see **FSK Input**)
2	AUXBUS IN/OUT (see KRC2 or XV-Series transverter instruction manual)
3	BAND1 OUT (see **Band Outputs**)
4	PTT IN (in parallel with MIC PTT)
5	Ground (RF isolated)
6	DIGOUT0 (see **Transverter Control**)
7	K3S ON signal (out) or TX INH (in) (see **Transverter Control**, **TX INH**)
8	POWER ON (see pg. 46)
9	BAND2 OUT (see **Band Outputs**)
10	KEYOUT-LP (10 mA keying output)
11	DIGOUT1 (see **DIGOUT1**)
12	Ground (RF isolated)
13	BAND0 OUT (see **Band Outputs**)
14	BAND3 OUT (see **Band Outputs**)
15	EXT ALC input (see **External ALC**, pg. 29)



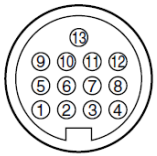
Band	BAND3	BAND2	BAND1	BAND0
160 m	0	0	0	1
80 m	0	0	1	0
60 m	0	0	0	0
40 m	0	0	1	1
30 m	0	1	0	0
20 m	0	1	0	1
17 m	0	1	1	0
15 m	0	1	1	1
12 m	1	0	0	0
10 m	1	0	0	1
6 m	1	0	1	0

ICOM Band Data Output

- IC-7700, 7800, 7851, 7600, 7610
  Standard 7-pin DIN:

ACC 2	PIN No.	NAME
7-pin  Rear panel view	1	8 V
	2	GND
	3	SEND*1
	4	BAND
	5	ALC
	6	TRV
	7	13.8 V

IC-7300, IC-7410
Standard 13-pin DIN:

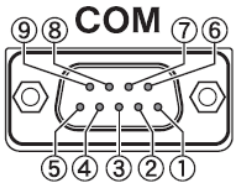
ACC	PIN No.	NAME
13-pin  Rear panel view	1	8 V
	2	GND
	3	SEND*1
	4	BDT
	5	BAND
	6	ALC
	7	NC
	8	13.8 V
	9	TKEY
	10	FSKK
	11	MOD
	12	AF/IF (IF=12 kHz)*2
	13	SQL S

① brown ⑧ gray
② red ⑨ white
③ orange ⑩ black
④ yellow ⑪ pink
⑤ green ⑫ light blue
⑥ blue
⑦ purple ⑬ light green

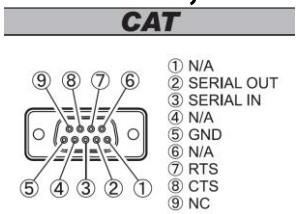
Color refers to the cable strands of the supplied cable.

Exact Frequency Output via RS-232

- Kenwood TS-590SG, TS-890S, TS-990S “COM” DE-9M



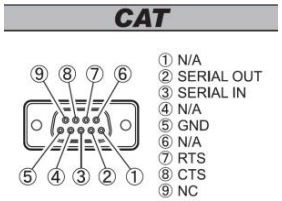
  - COM connector is not tied to Kenwood USB port used by logger
  - One device can “poll” radio for frequency via RS232 cable
- Yaesu FTdx3000, FTdx5000, FTdx9000 “CAT” DE-9M



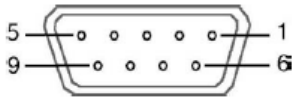
  - No USB, or FTdx3000 “CAT SELECT” RS-232
  - PC polls radio, peripherals “just listen” (Pin 2 wired, Pin 3 open)
    - Custom RS-232 “Y-Cable” or “S-BOX” required for sharing

Exact Frequency Output via RS-232

- Yaesu FTdx10, FTdx101D, FTdx101MP
  DE-9M



  - COM connector independent of USB
  - One device can “poll” radio for frequency via RS232 cable
- Elecraft K3 or K3S
  DE-9F

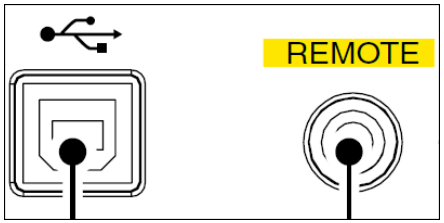


RS232 Connector (female, on KIO3 panel)

  - No *independent* USB connector (Elecraft K4 RS232 *is* independent)
  - PC polls radio, peripherals “just listen” (Pin 2 wired, Pin 3 open)
    - Custom RS-232 “Y-Cable” or “S-BOX” required

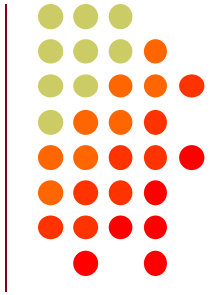
Exact Frequency Output via ICOM CI-V

- All ICOM rigs except IC-705 provide a legacy "REMOTE" (CI-V) connector
  3.5mm MONO



- Two wire serial bus, 19200 baud max
- Important menu setting:
  Set USB CI-V Port to Unlink from [REMOTE]
  (Not available on older rigs like IC-7700)

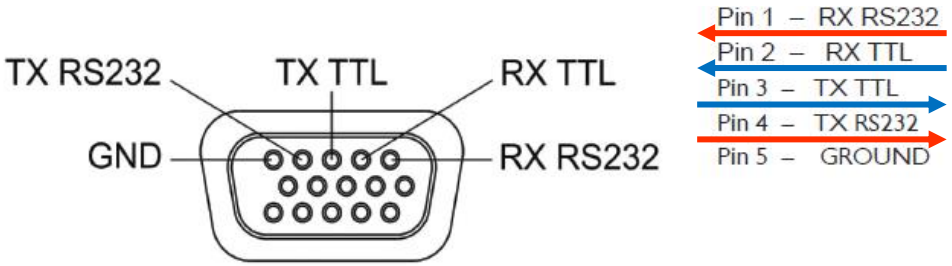
Automatic Amplifiers



- Usually Solid State and Broadband
- Often include built-in tuners
- Communicate with transceiver via Band Data, RS-232, ICOM CI-V, or Ethernet LAN
- Change bands automatically, no RF transmission required
- Usually have internal RF Frequency Counter as safety, in case RF input doesn't match band or frequency supplied from the transceiver

ACOM 2000A Amplifier

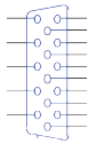
- With new RCU
  "CAT" connector: DE-15F



ACOM Solid State Amplifiers

- ACOM 500S, 600S, 700S, 1200S “CAT/AUX” connector: DE-15F

Table 2-1

CAT/AUX interface	PIN NO.	PIN NAME	DESCRIPTION	SPECIFICATIONS
 Rear panel view	1	RxD	Received Data	TTL input
	2	RxD	Received Data	RS232 input
	3	TxD	Transmitted Data	RS232 output
	4	TxD	Transmitted Data	TTL output
	5	GND	Ground	0 Volt
	6	BAND voltage	Analogue input	0 to +8V
	7	Band data 0	Bit 0	TTL input
	8	Band data 1	Bit 1	TTL input
	9	Band data 2	Bit 2	TTL input
	10	Band data 3	Bit 3	TTL input
	11	ON RMT	Remote Pwr On	+4.5 to + 15V / 3mA max
	12	Debug mode	CPU only Pwr Input	+8 to + 15V / 0.4A
	13	KEY-IN	Tx Request	Less than +12V / 6mA
	14	KEY-OUT	Tx Ready	O.C. output, up to +50V / 20mA
	15	GND	Ground	0 Volt

Ameritron Solid State Amplifiers

- For ALS-500M, ALS-600, ALS-1300 series, use ARI-500 Interface and transceiver cables

Elecraft KPA500

- "AUX" Connector: DE-15M for Band Data, K3/K4 ICOM Band Data, but no ICOM CI-V support.
  RS232 "XCVR" Connector: DE-9M (RS232) for Kenwood

Signal Name	Pin	Direction	Notes
Band VRef (Icom)	1	In	Reference for Icom input – connect to 8V
AuxBus I/O	2	Out	K3 Only
Band1 In	3	In	BCD Band Input – Bit 1*
NC	4		
GND	5		
Band V (Icom)	6	In	Uses Icom standard band voltages
Alarm Out	7	Out	Drives low for fault input Not used by K3. Must not be connected to K3.
Power On/Off	8	In	Pulse low to turn KPA on or off – do not hold low!
Band2 In	9	In	BCD Band Input – Bit 2*
Key	10	In	Low enables amplification. Internally pulled up to +5V. Sources 1 mA when pulled to ground. Diode isolated from the PA KEY RCA jack.
Inhibit#	11	In	Low inhibits amplifier operation
GND	12		
Band0 In	13	In	BCD Band Input – Bit 0*
Band3 In	14	In	BCD Band Input – Bit 3*
ALC	15	Out	ALC output to transceiver

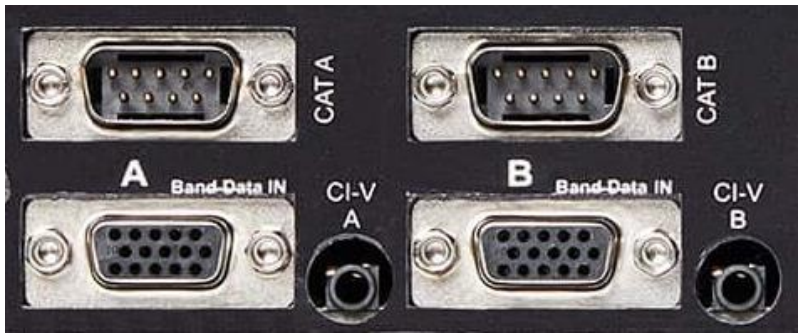
Elecraft KPA1500

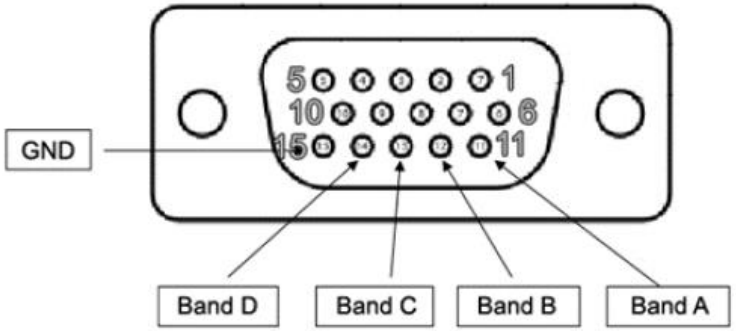
- With built-in Antenna Tuner
  "AUX" Connector: DE-15M for Band Data, K3/K4
  "XCVR Serial" Connector: 3.5mm TRS for Kenwood / Yaesu RS-232 *or* Icom CI-V

Signal Name	Pin	Direction	Notes
Band VRef (Icom)	1	In	Reference for Icom input – connect to 8V
AuxBus I/O	2	Out	K3 Only
Band1 In	3	In	BCD Band Input – Bit 1*
NC	4		
GND	5		
Band V (Icom)	6	In	Uses Icom standard band voltages
Alarm Out	7	Out	Drives low for fault input Not used by K3. Must not be connected to K3.
Power On/Off	8	In	Pulse low to turn KPA on or off – do not hold low!
Band2 In	9	In	BCD Band Input – Bit 2*
Key	10	In	Low enables amplification. Internally pulled up to +5V. Sources 1 mA when pulled to ground. Diode isolated from the PA KEY RCA jack.
Inhibit#	11	In	Low inhibits amplifier operation
GND	12		
Band0 In	13	In	BCD Band Input – Bit 0*
Band3 In	14	In	BCD Band Input – Bit 3*
ALC	15	Out	ALC output to transceiver

FlexRadio Power Genius XL (PGXL)

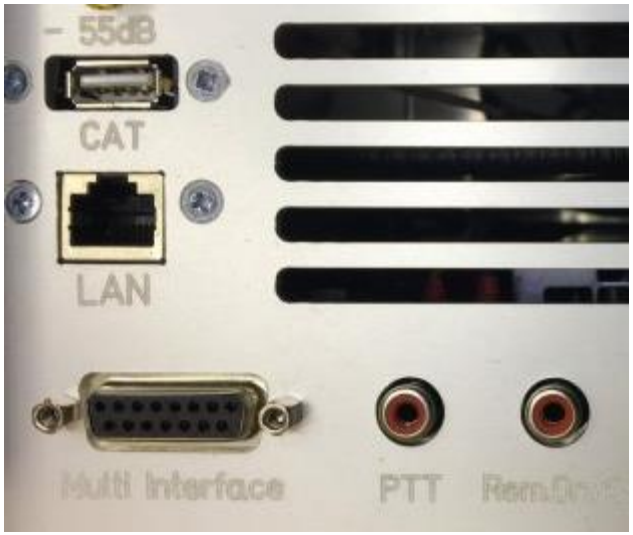
- DE-15F for Elecraft or Yaesu Band Data (x 2)
  DE-9M for RS-232 (x 2), Ethernet LAN port for Flex,
  3.5mm TS for ICOM CI-V (x 2)





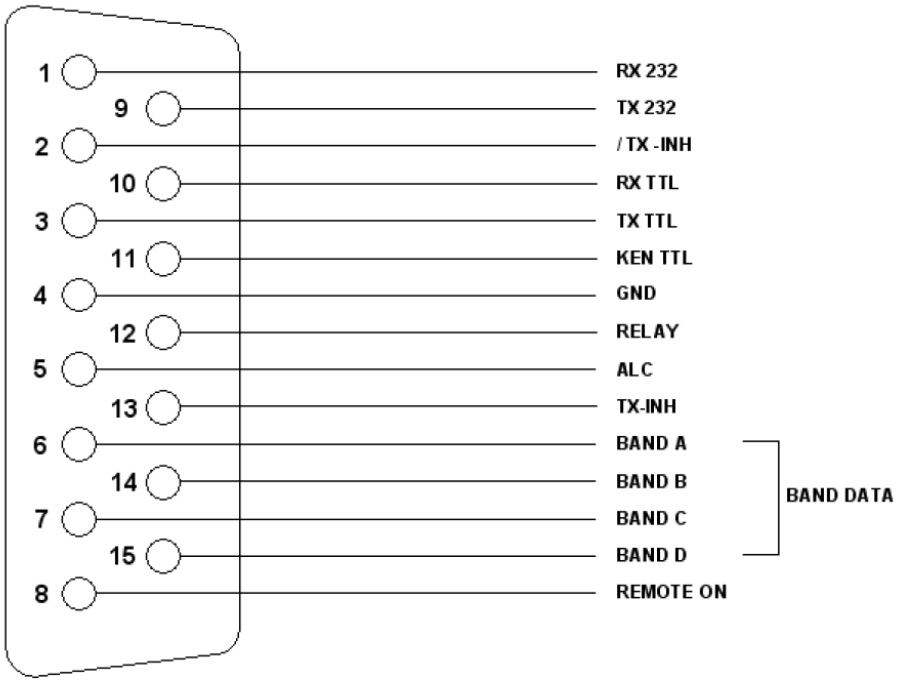
RF Kit RF2K-S

- USB Type A Connector Supports FTDI USB-to-Serial adapters or USB-to-CI-V (CT-17) interface cables. LAN support. No Band Data input.

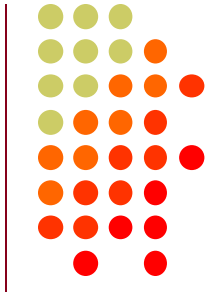


SPE Expert 1K, 1.3K, 1.5K, 2.0K-FA

- DA-15F (x 2) for RS232, CI-V, and Band Data input



Standalone Band Decoders



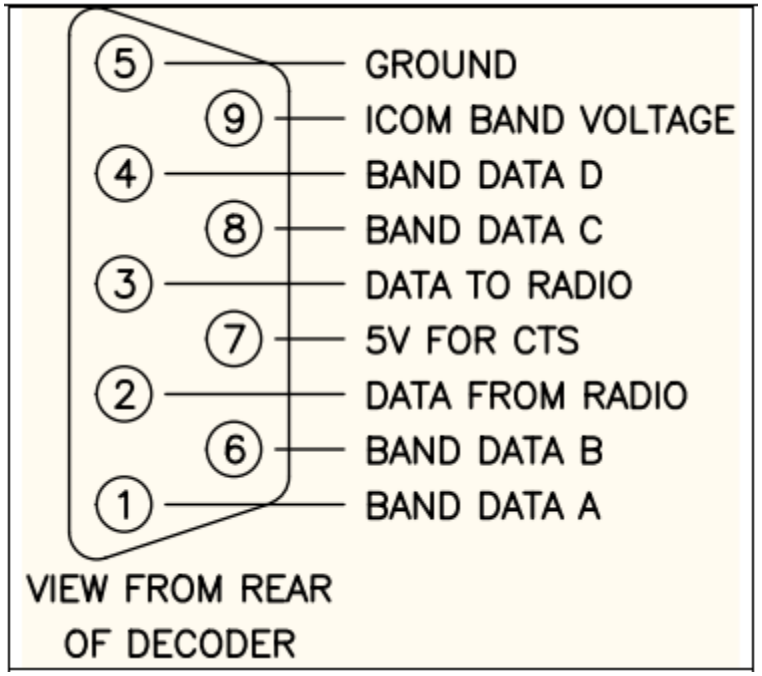
- Connect Band Decoder input to transceiver
  - Band Data, CI-V, or RS-232
- Connect Band Decoder output to Antenna Relay Box and/or Bandpass Filter Box
- Output is typically 13.8V “Source” or 0.0V “Sink”, one line per band
- For triband antennas, Band Decoder can be programmed to select same output line for multiple bands

Array Solutions BandMaster III, IV, V, Shack Master SM-8

- Decodes Band Data, RS-232, or ICOM CI-V
- Drives Antenna Relay box and/or BPF box

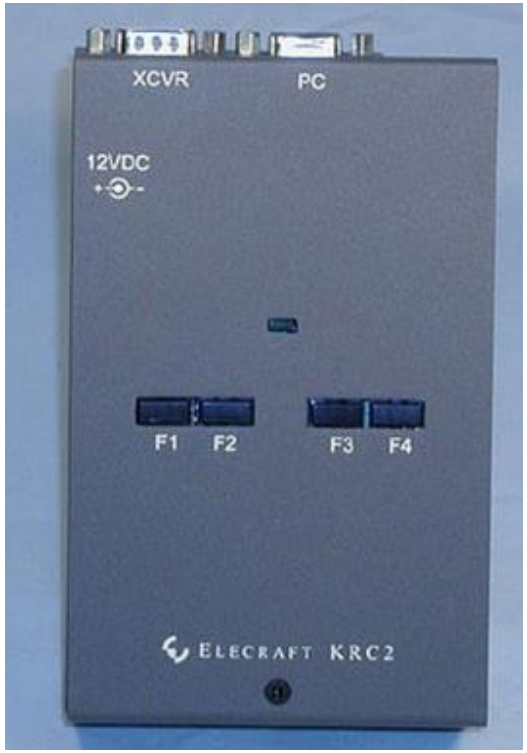
Array Solutions BandMaster III, IV, V

- All use the same DE-9M connector for Band Data, Icom Band Voltage, and RXD/TXD RS-232 DATA



Elecraft KRC-2 Band Decoder

- Interior screw terminals for inputs and outputs



HamPlus MBD-8G Band Decoder

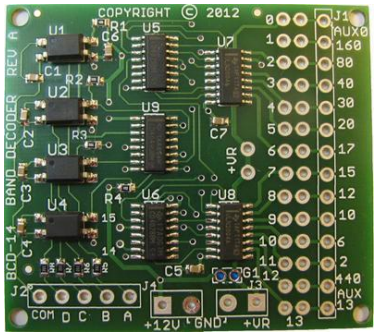
- Decodes ICOM CI-V, Elecraft/Yaesu BCD, and Kenwood RS-232
- Drives HamPlus Antenna Relays
- “SEND” In / Out jacks prevent antenna switching during TX

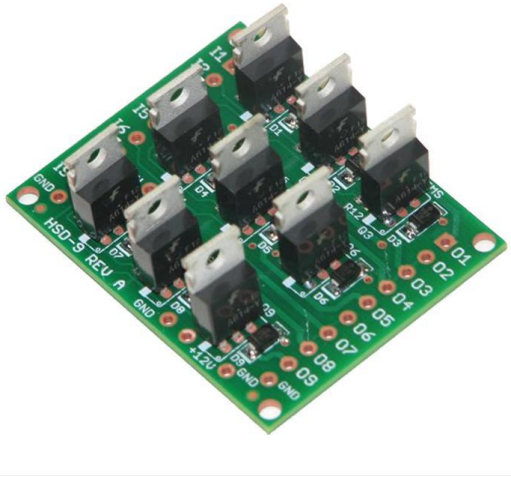
Top Ten Devices
Band Decoder and Band Aide

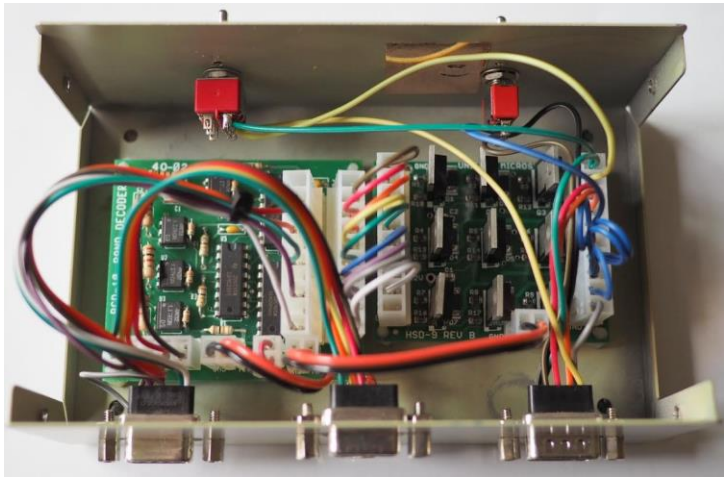
- Yaesu/Elecraft Band Data
- No longer in production ☹

Unified Microsystems BCD-14 + HSD-9

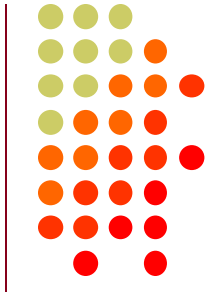
- Yaesu/Elecraft Band Data with “High Side Driver”
- “Some assembly required”







Automatic Antenna Switches



- Controlled by one or two band decoders
- Switches to correct antenna automatically, when rig changes band
- Prevents two rigs from using the same TX antenna at the same time
- Uses low loss, high power relays

Ameritron RCS-8V and RCS-10
8- and 10-port Remote Coax Switches

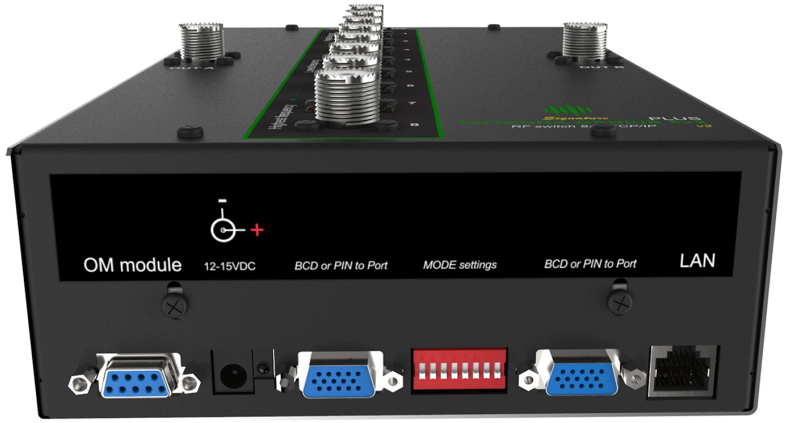
- Replace the Ameritron manual switchbox with an automatic band decoder
- One +13.8V line in control cable selects one antenna port

Array Solutions EightPak 2x8 Antenna Switch

- Controlled by a pair of BandMaster Band Decoders
- Prevents 2 radios from connecting to the same antenna at the same time

FlexRadio Antenna 8x2 Switch

- DE-15F for Elecraft or Yaesu Band Data (x 2)
  Same Band Data pins as PGXL.
  LAN Port for Flex.



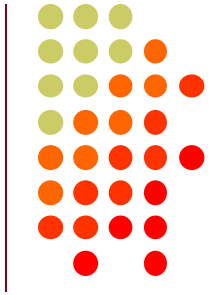
HamPlus AS-62 Antenna Switch

- 2 inputs, 6 Outputs
- Driven by HamPlus Band Decoder

microHAM micro SIX and DOUBLE SIX, switches (10 port version also available)

- One +13.8V line in control cable selects antenna port
- Connect control cable to Band Decoder output

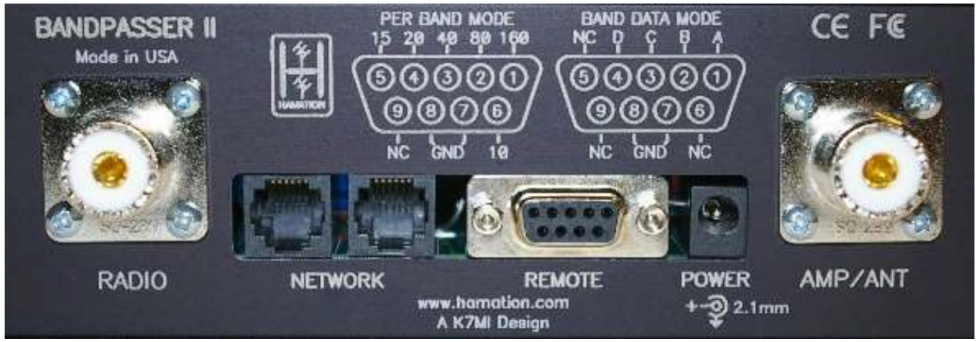
Automatic Bandpass Filters



- A must for operating SO2R, or Multi-Op, or Field Day with more than one TX
- Attenuates nearby signals from adjacent bands
- Typically 100 to 200W max.
- High Power BPFs are also available, but much larger, much more expensive
- Will not attenuate in-band harmonics
- Switch BPFs to correct band *automatically* to prevent filter damage, high SWR

Array Solutions AS-419 “BandPasser II”

- Same as SureFire BF-100 with different label
- Built-in Band Decoder for Elecraft / Yaesu Band DATA



DuneStar 600

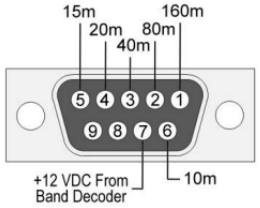
- Requires Source or Sink Band Decoder to DE-9M connector (see manual)

DB9 Pin outs:

(1) Brown 160M
(2) Red 80M
(3) Orange 40M
(4) Yellow 20M
(5) Green 15M
(6) Blue 10M
(7) Violet Ground (gray on older models)
(8) White Not Used
(9) Black +12V
Shell Shield

DX Engineering DXE-419-P

- Requires separate Band Decoder with “Sink” outputs to DE-9F “BAND IN” jack:

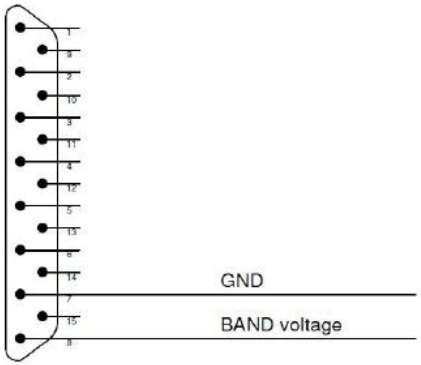


DB-9 Connector on rear of unit

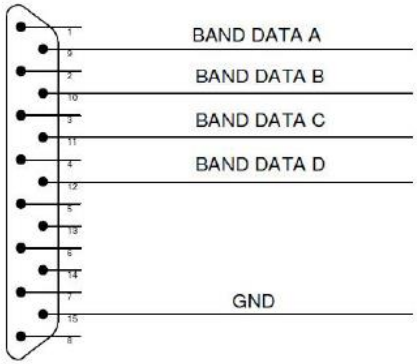
Pin	Band Decoder minus trigger signal
1	160 meters selected
2	80 meters selected
3	40 meters selected
4	20 meters selected
5	15 meters selected
6	10 meters selected
7	+12 VDC from Band Decoder
8	No Connection
9	No Connection

OM Power OM6BPF

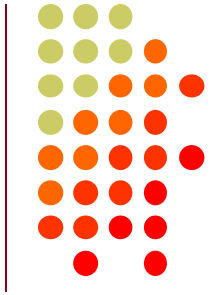
- Built-in Band Decoder (Elecraft, Yaesu, Icom Band Voltage)



BPF 6 FILTER



Automatic Antenna Tuners



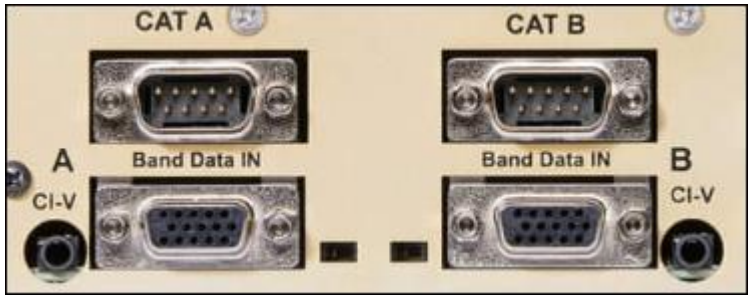
- Once programmed for each segment, tuner remembers the tuning solution(s) for that frequency
- Tuner restores correct tuning solution, based on rig's frequency, well before you transmit
- Tuner can bypass itself automatically when SWR is low
- Tuner may remember multiple solutions per frequency to support multiple antennas

Elecraft KAT500

- DE-15M and DE-15F passthrough for Elecraft AUX CABLES
- 3.5mm TRS “PC DATA” for Kenwood RS-232

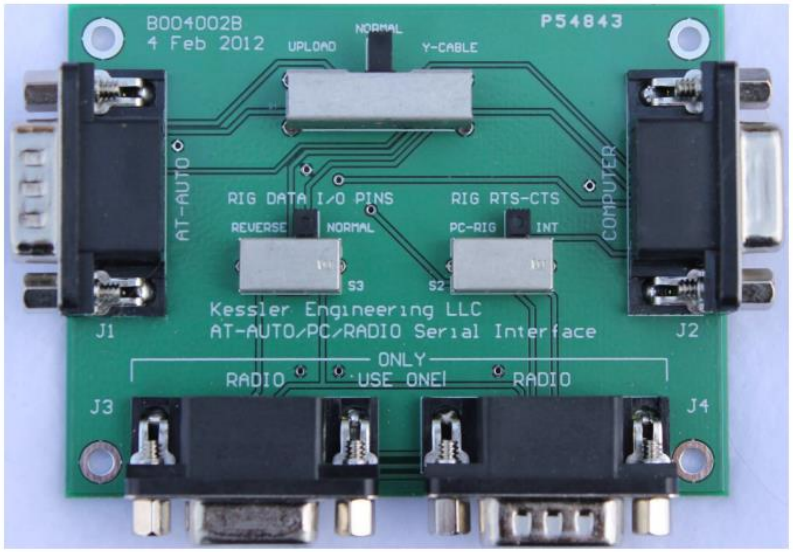
FlexRadio Tuner Genius XL (TGXL)

- Same connectors and pins as PGXL
  Recommendation: Use CAT or CI-V



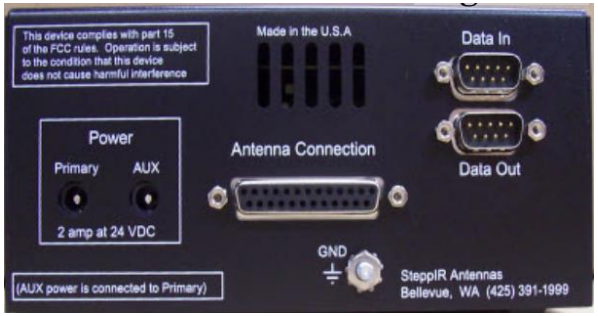
Kessler Engineering AT-AUTO

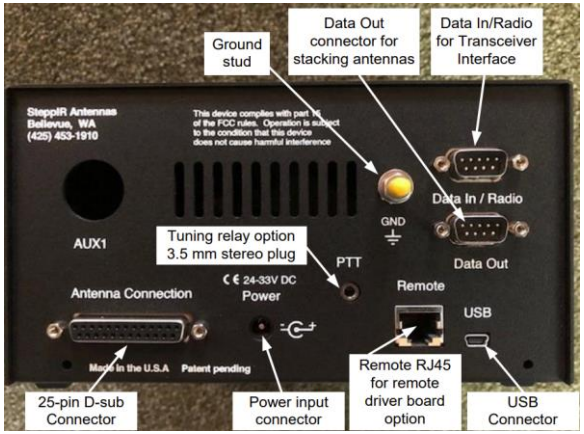
- Not to be confused with Palstar AT-AUTO
- The Kessler can track rig frequency by RS232 instead of RF



SteppIR Automatic Antenna Controller

- FluidMotion, SDA100, OptimizIR (SDA2000)
- Tracks only by RS-232 or CI-V
- Custom SteppIR interface cable or S-BOX required
- Tuning Relay Interrupt opens amp. keying line while antenna is tuning

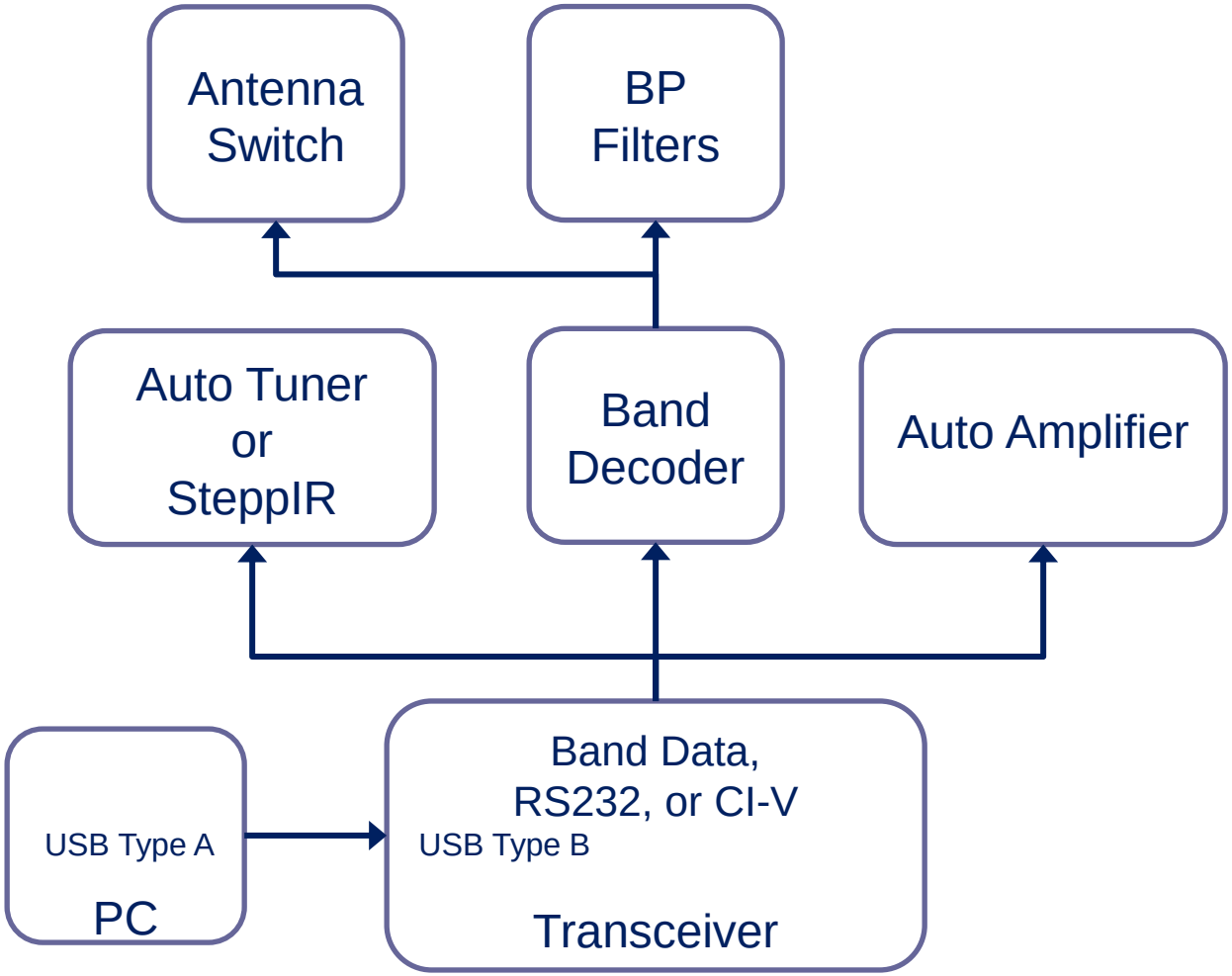




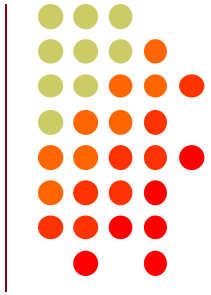
WiMo Ultrabeam RCU-06 Antenna Controller

- Tracks by RS-232 or CI-V, Poll ON or OFF set by app.
- Tuning Relay Interrupt opens Amp. Keying Line while tuning

“So how do I connect all this together?”



Interface Cables



- Check DXE website or eBay
  - Many premade “Interface Cables” are listed
  - But some only provide a “Band Data” and “Keying” connection.
- You can also try to build your own from the documentation and pinouts
- Things get more complicated when you need to split Band Data Outputs or a single RS-232 connector to multiple devices (PC, Amplifier, BP Filters, SteppIR Controller)

Y-Cables for Band Data outputs

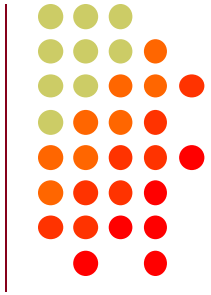
- Wiring Band Data Lines in parallel generally works OK, if voltages are compatible
- Winford Engineering CDY15HDMFF:

- N6TV Y-BOX:

Sharing Transceiver RS-232 port requires special wiring

- Cannot wire two Pin 3s (“TXD”) lines in parallel
- Simple DE-9 Y-cables will not work
- Connect only *one* TXD line to radio for polling
- Wire RXD lines in parallel to all devices
- The N6TV S-BOX and S-BOX-USB
  - Connects rig to SteppIR controllers, ACOM, SPE, RF Kit, etc. using standard molded cables

Key Recommendations



- When possible, let the transceiver drive the devices, instead of PC ports or software
- Use Band Data when frequency not needed
  - BPFs, Antenna Switches, Broadband Amplifiers
- Use RS-232 or CI-V data when frequency needed
  - Amps with tuners, SteppIR Controllers, automatic tuners
- Use off-the-shelf solutions if you're not comfortable wiring your own interconnection cables, in other words …
- "If you don't know what you're doing, don't *do* anything."

References

- https://www.qrz.com/db/n6tv - Links to this and other presentations
- https://bit.ly/Y-BOX - The “Y-BOX” by N6TV
- https://bit.ly/S-BOX - The “Serial Box” by N6TV
- n6tv@arrl.net

Questions?